DOCUMENT RESUME

ED 290 320 FL 017 095

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TITLE Spoken Language Phonotactics.
PUB DATE [88]
NOTE 30p.
PUB TYPE Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Discourse Analysis; Educational Strategies; *English; Morphophonemics; *Oral Language; *Phonology; Second Language Instruction; Speech Acts; *Suprasegmentals; Syllables

ABSTRACT

The transformation that language undergoes when it becomes speech is examined in English. Statistical analysis of a representative sample of natural, informal speech reveals a number of characteristics of dynamic speech that distinguish it from static (citation form or pre-dynamic) linguistic form. It appears that in running speech, vowels and consonants, words and sentences are less central to speech dynamics than sonorants and obstruents, syllables, and syllabic phrases. The findings include these: (1) when language is learned in its dynamic (spoken) rather than static form, the basic unit contains more phonemes, making it more complex to learn; (2) utterances are predominantly made up of sonorants and other voiced sounds; (3) running speech can tolerate a maximum of five consonants in sequence, and the sequences are regular and predictable; (4) syllable boundaries are fluid and can be expected to change configuration through restructuring; (5) syllable combinations affect syllabic distinctions; and (6) application of the variable fast speech rules still results in regularly shaped utterances. It is suggested that incorporating information about speech dynamics into second language instruction may facilitate acquisition of oral fluency. (MSE)

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SPOKEN LANGUAGE PHONOTACTICS

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(Spoken Language ...)

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Abstract

The metamorphosis of language (e.g., words, phrases, sentences, text) into speech (quasi-uninterrupted strings of utterances) entails a host of contractions, assimilations, reductions, loss, syllabic restructuring and the like. These absorption processes can cause modifications in the canonical shape of the spoken language. On the basis of a representative sample of natural, informal speech , the ultimate canonical shape of English, represented in its actual spoken (dynamic) form, is here investigated for its regularities and correspondences to citation form phonotactics.

In running speech, vowels and consonants, words and sentences are less pivotal entitities for an understanding of the speech dynamic domain than sonorants and obstruents, syllables and syllabic phrases (i.e. 'runs' of articulated speech defined by their respective pausal envelopes), so that a separate phonotactics operative in this domain emerges. Incorporating such information into second language pedagogy may facilitate oral fluency acquisition.

Spoken Language

1. Introduction

Whenever language is studied as actual speech--a real event in time--the exigencies of production will have altered its conventional citation form representation considerably, as the playful rendition of Mares eat oats, and does eat oats, and little lambs eat ivy exemplifies. More than a mere curiosity, this example highlights one of the more common transformations from pre-dynamic language to dynamic speech, for instance through linking processes (cf. liaison, sandhi) which in turn alter syllable structure in spoken forms. While such processes convert citation forms into speech dynamic events, and hence simultaneously into another, temporal dimension, it would be an oversimplification to consider the switch simply an equivalent realization at another level. The motivating force at this juncture of linguistic domains is covariation (cf. Hieke 1987a) rather than derivation. Recent investigations into the speech dynamic domain make it increasingly obvious that vowels, consonants, words and sentences are less pivotal entities than sonorants and obstruents, syllables and syllabic phrases (syllabic phrases are 'runs' of articulated speech as defined by their pausal envelopes). Such a position makes syllables and syllabic phrases central to a phonostylistics of American English casual speech.

Although lexical strings are, of course, convertible from the conceptual (citation form) domain to the event (dynamic) domain (and vice versa, namely during perception), they must not be considered simply interchangeable. Experimentation has shown that isolate words strung together often appear unintelligible to listeners or speech detection computers, just as dynamic speech forms excised from running speech and presented in isolation may be incomprehensible (Oakeshott-Taylor 1980; Goldstein 1983). Clearly, every time language is converted into running speech, a remarkable metamorphosis takes place, where absorption processes (serving ease of articulation) affect segments and syllables in all sorts of ways (for an overview, cf. Hieke 1984; 1986; 1987b). What is often overlooked is that dynamic speech does not reliably reflect words as distinct units, even in rather deliberate modes, although the quasi-uninterrupted nature of the acoustic signal ought to have made it fairly obvious.

For its temporal, minimally abstract representation, parameters other than words evidently serve to form the primary operational units of dynamic speech. The most prominent of these involve pausal envelopes as well as the umbrella of intonation contours. The conversion from language to speech has traditionally been formulated in terms of alterations of citation forms, supposedly because we proceed from lexical citation forms in order to produce speech, and resolve running speech into citation forms in order to understand its meaning. This approach has re-

sulted in a phonotactic description essentially just elaborating upon the lexicon. Even current accounts of connected speech (most recently Kaisse 1985) are more likely formulated from a traditional paradigmatic rather than a running speech viewpoint, and thus persist in specifying 'all stand-alone pronunciations' of a citation form (cf. Woods et al. 1976:3) instead of providing a frequency measure of how they occur in actual running speech.

Since absorption processes are not generally obligatory, even knowing what potential processes to assign to a citation form string may not reliably predict the exact configuration of that portion in dynamic speech; accounting for such phenomena from the top down, as it were, will therefore not do, but must be accomplished on the basis of actual running speech, at least if the intent is to capture its regularities statistically. In addition, the notion that the conversion from one domain to another may in itself precipitate alterations has received only peripheral attention so far, which accounts for the lack of an explicit specification of a dynamic phonotactics.

This invites attention to the phonotactics of representative text, not just potential context-sensitive variants of strings (aside from the question whether a separate speech dynamic domain is plausible at this point or not). The degree of correspondence between pre-dynamic and dynamic domains must be considerable in any event but needs to be demonstrated statistically.

In the absence of a comprehensive theory of the spoken language, the exploration of a dynamic phonotactics--of actual running speech--provides one more avenue of approach for adding to our knowledge about the oral properties of language. For a start, the following therefore attempts to provide a straightforward statistical account of the performance characteristics of casual English speech.

2. The Data Base.

The statistical analysis of the present study is based on an extended sample of natural, informal American English speech (Carterette and Jones 1974; for a sample page, cf. Appendix 1). A number of helpful frequency measures have already been provided by the editors and form a basis for the calculations in the following. This data base, then, consists of transcribed conversations of--in each instance--three adults conversing in an informal setting. The transcriptions represent a faithful record of the acoustic signal (faithful to the extent that bursts of speech are recorded as such, without conventional word divisions, that is breaks are indicated only <u>where there actually are perceptible pauses).</u>

Carterette and Jones (1974:27-30) present a strong case for the superiority of their materials over previous studies (Whitney 1874; Dewey 1923; French, Carter and Koenig 1930; Trnka 1935;

Voelker 1937; Fry 1947; Tobias 1947; Hayden 1950; Hultzen, Allen, and Miron 1964; Roberts 1965). Although Svartvik and Quirk (1980) postdates Carterette and Jones (1974), that monumental work would also rightfully be considered flawed by them for employing exclusively conventional word boundary markings. To their credit, Carterette and Jones indeed present casual speech as natural--in the sense of connected--speech, perhaps for the first time in a speech sample of this magnitude (although it is not clear how much the transcribing phonologists deleted as unintelligible). Previous accounts, while based on natural speech samples originally, arrange the data ultimately in word-length units for their statistic display and thus inadvertently skew the results. To reiterate, the viewpoint here is that conventional words are an artifact of the citation domain of language (as evident in the highly prevalent syllabic restructuring, for instance; even in the brief example cited earlier it occurs numerous times).

Time and again, the editors emphasize the unique nature of dynamic speech; to them it is obviously quite clear that syllables are "the natural units of speech" (1974:40). Their extensive experience in analyzing natural speech, furthermore, has led them to the "profound conviction that the word is not ordinarily a natural unit of the spoken language" (1974:43). Since the evidence to date convincingly supports that position, the basic operating units at the level of dynamic speech are here

understood to be

1) the dynamic syllable, and
2) the syllabic phrase (however much speech is articulated between silent pauses, i.e. 'runs' of articulated speech as defined by their pausal envelopes).

Carterette and Jones make repeated reference to the striking differences between what is here referred to as dynamic and pre-dynamic (citation form) speech. Their evidence shows that the "phonemic word is on the average three times as long as lexical words" in number of phonemes (1974:26). The syllabic phrase ('phonemic word' or '-phrase' in their terminology) thus constitutes added 'load' for purposes of production as well as perception.

This may explain why gaining oral competence in a second language is particularly problematic, by the way. Although dynamic speech thus places greater demands upon practitioners through its increased unit size, additional context compensates for the greater load factor and may facilitate semantic template matching, so crucial to effective speech perception.

3. The Phonotactics of the Spoken Language

3.1 Phonemes and Syllabic Phrases

To begin with, several general parameter differences between

pre-dynamic and dynamic domains can be noted. The adult speech sample under consideration here (Carterette and Jones 1974:367-429) contains a total of 48708 phonemes, and that in form of 15694 words in 1630 utterances (defined as bounded by a full stop). It is thus a sample sufficiently large to be considered representative. As far as citation form representation is concerned, this amounts to a phoneme/word ratio of 3.10. An equivalent ratio for dynamic forms can be expressed in terms of phonemes per syllabic phrase--the syllabic phrase for obvious reasons being the most prominent isolable entity at this level. Since there are 4140 syllabic phrases altogether, we can speak of a ratio of 11.8 phonemes/syllabic phrase, a steep increase indeed.

But even that figure could be revised upward once the dyadic nature of the speech sample is considered. In dyads, after all, potential syllabic phrases are regularly curtailed as a normal turn-taking phenomenon whenever speakers have their stream of speech interrupted by other conversants. If such turn-takings are therefore factored out of the speech sample (something the editors did not consider), the number of syllabic phrases decreases to 3287. This would then yield a phoneme/syllabic phrase ratio of 14.8, in effect a five-fold increase in number of phonemes in dynamic versus pre-dynamic domains. A spread of 3.1 phonemes/word in (pre-dynamic) citation forms versus 14.8 phonemes/syllabic phrase in dynamic forms constitutes one crucial

difference in the two language domains under discussion.

The basic operating unit of dynamic speech consequently constitutes a much greater load factor for the processing capacity of speakers as well as listeners, and one concrete explanation for the universally observed difficulty L2 learners have in gaining control over the oral properties of language.

Another rather pronounced difference between dynamic and static (pre-dynamic) speech can be noted in the ratio of syllabic phrases per utterance. While the data base does not yield the total syllable count, it is nevertheless possible to provide a ratio of syllabic phrase to utterance, i.e. 2.54 syllabic phrases/utterance. This figure indicates that utterances (or in whatever way 'complete thought units' may be defined) do not stand in a one-to-one relationship to syllabic phrases by any means. Utterances, as this figure shows, are divisible into several syllabic phrases, each of which is by definition governed by a separate intonation contour and thus to be considered a self-contained speech dynamic unit.

Despite the wholesale absorption processes pre-dynamic speech undergoes in transition as already pointed out, the basic elements of running speech do not differ radically, of course: 28988 consonant and 19720 vowel phonemes, about what would be expected in pre-dynamic (citation form) distributions, namely in

a consonant/vowel ratio of 60/40, with vowels even less prevalent (30%) in final position (1974:478). The striking nature of dynamic speech becomes evident only when we look at the ratio of obstruents to sonorants. Here the present sample yields the following distribution:

Obstruents:				16815	= 35%
Sonorants:					
1. Vowels	19720	=	40%		
2. Nasals and approximants	12173	=	25%	31893	= 65%

Thus, while there are more consonants (60%) than vowels (40%) as such, a closer look at segment distribution in dynamic speech shows that fully two-thirds of all sounds are sonorants. This leads to the next question about the relative distribution of voiced to voiceless sounds, a ratio derivable from figures supplied by Carterette and Jones (1974:448-449):

Vd. Cons.:	19071	=	39.154%	Vl. Cons.:	9917	=	20.36%
Vowels:	17755	=	36.451%				
Diphthongs:	1965	=	4.035%				
TOTAL:	38791	=	79.64%		9917	=	20.36%

The nature of dynamic speech can therefore be characterized as overwhelmingly voiced: although only a third of all phonemes are vowels, running speech is in fact 80% voiced. Not only are voiceless stops, as a natural extension of the facts above, quite infrequent (i.e. a mere 9.4% of all phonemes), but they are prominently marked in running speech in that they do, in fact, cause momentary internal caesuras in intonation contours (as observed in related studies on acoustic energy displays with a 40 ms cut-off). That, incidentally, together with their high representation in certain inflectional suffixes makes them prime candidates for boundary marking, a further clue to their potential flag function in speech (Hieke 1987a).

3.2 Patterns of Sonority

The high prevalence of sonorants (65%) and of voiced segments in dynamic speech per se (80%) finds its reflection in the canonical shape of English syllables. Sonority radiates out from the vocalic nucleus in both directions, resulting in typical canonical shapes. For instance, in connection with two-consonant clusters (Stageberg 1974:75), the following order in pre-vocalic sequences can be observed:

O: # stop - fricative - affricate - V

S: # nasal - lateral - glide - V

Post-vocalic sequences are a mirror image of pre-vocalic ones:

O: V - affricate - fricative - stop #

S: V - glide - lateral - nasal #

Syllables therefore typically have the following shape:

(O)(S)V(S)(O).(O)(S)V(S)(O)

(where periods mark syllable boundaries and parentheses optionality).

Intended to hold for initial and final two-consonant (2-C) clusters in citation form representations (Stageberg 1974:75), this scheme is also valid for dynamic canonical shape in general. Our perception of the notion syllable must derive from this high regularity, at least in large part, since the same effect could not be created primarily by plus junctures (as was commonly held) because of the high frequency of ambisyllabicity in dynamic speech, in which case plus juncture is absent.

The OSVSO.OSVSO scheme has important implications for a dynamic phonotactics:

1. Maximally two consonants occur in juxtaposition intrasyllabically.

2. Maximally two obstruents occur in juxtaposition even intersyllabically.

Citation form (pre-dynamic) phonotactics is not so rigorously restricted, of course, and clusters of more than two consonants are quite common, the absolute limit for English being #CCC and CCCCC#. As the conversion to dynamic phonotactics causes considerable reduction and other absorptive processes to take effect (viz.: [wʊ̯jə hɪɾɪtʔtam] for Would you hit it to Tom? (Klatt

1980:249), the OSVSO.OSVSO scheme does indeed hold for that domain, and with very few exceptions (amounting to no more than .63%). If it is considered that given the predominance of consonants, chance juxtapositions of text would be expected to result in rather long strings of consonants from time to time (as frequently encountered in pre-dynamic representation), this insignificant percentage--made up of clusters of no more than 3-C--is surprising.

The speech sample utilized here provides no dynamic syllabications (although the corresponding graphemic record shows the ultimate citation form canonical forms, of course). To determine the canonical shape of dynamic clusters, all relevant consonant sequences of at least three elements regardless of syllable affiliation were charted and syllabified as shown below. The absolute consonant sequence in dynamic speech irrespective of syllable boundaries was thereby determined to be five (cf. pentaphone). No maximal, 5-C compilations--rare in themselves--do in fact appear in intrasyllabic configuration, however. The largest intrasyllabic cluster turned out to be 3-C of the type #CCC or CCC# (and amounting to a mere .63% of the corpus, as pointed out).

It was found that all consonant sequences, once resolved into appropriate syllable membership according to the graphemic record provided, follow consonant cluster rules for English

citation forms (cf. below), and that without exception, which means that the same rule of canonical shape applies to pre-dynamic and dynamic forms despite the fact that the latter have been 'corrupted' by considerable absorptive processes. No matter what the citation configuration for juxtaposed consonants may have been originally, once absorption phenomena have applied, the resulting forms will always adhere to the strictures of the conventional 3-C cluster.

There were altogether 1171 consonant sequences which transcend the standard pattern diagrammed above. Syllabication then resulted, without exception, in consonant clusters of maximally three elements either pre- or postvocalically. As such, these clusters are rare in dynamic speech (prevocalically, 3-C clusters amount to less than one-tenth of one percent (.074%) of the entire corpus, and to about half of one percent (.56%) postvocalically). There were a total of 103 instances of 3-C clusters, of which 12 (12%) were initial, viz. #CCC, and the remainder, 91 or 88%, final, viz. CCC#. To complete the picture of possible sound sequences in dynamic speech, the following distribution was noted for consonant clusters.

3.2.1 #CCC

Of the nine permissible #CCC types in English, only four actually occur in this particular sample; these are listed in the

first column:

/spl/ /spr/

/str/ /spy/

/skl/ /sty/

/skr/ /sky/

/skw/

The initial (syllable-initial, not necessarily word-initial; cf. below) 3-C clusters in dynamic speech follow without exception the well-known rule:

1 = /s/

2 = /p,t,k/

3 = /w,r,l,y/.

The breakdown for all consonant sequences in the text which contain 3-C clusters of some type is therefore as follows: ('=>' = consonant sequence resolved into these respective syllables:)

1.	#CCC	10	(cf. above)
2.	CCCCC => CC.CCC	1	/fts.streyt/
3.	CCCC => C.CCC	1	/wat.striyt/
	TOTAL:	12	

It should be noted that all of these 12 instances of initial 3-C clusters involve monomorphemic clusters, while final clusters, as will be seen below, are almost exclusively polymorphemic in character.

3.22 CCC#

The balance of 91 3-C clusters are syllable-final, and in fact also word-final. Their breakdown is as follows:

4.	CCC#	73	(cf. below for details)
5.	CCCCC ⇒ CCC.CC	2	/fərst.θriy/;/ad.vænst.swɪmɪŋ/
6.	CCCC ⇒ CCC.C	16	/pæ.rents.went/;/saundz.sow/ /sports.ǰuw/;/wərks.ðer/ /mənθs.tə.mə.row/;/wərkt.wɪð/ /gərlz.kən/;/ɔbǰekts.yuw/, etc.
	TOTAL:	91	

It should be noted that except for five instances (every one a token of the word /wərld/), all 91 occurrences are bimorphemic clusters (just as world historically contains two morphemes).

3.2.3 Summary of Consonant Sequences of 3 to 5 Members

A. Actual 3-C clusters:

initial	12
final	91
TOTAL:	103

B. Other C sequences:

CCCC ⇒ CC.CC	29
C.C.CC	1
C.CC.C	2
TOTAL:	32
CCC ⇒ C.CC;	
CCC ⇒ CC.C	
CCC ⇒ C.C.C	1036
GRAND TOTAL:	1171

Thus it can be seen that of the 1171 consonant sequences extant in the 48708 phoneme sample, only a minute minority, namely half of one percent, even forms 3-C clusters (three being the intrasyllabic maximum and five the intersyllabic maximal consonant sequence in dynamic speech). Not a single instance of violating the dictates of citation form canonical shape was found.

3.3 Final Consonant Clusters

We now turn to an explanation of final 3-C clusters and their regularities. Beyond the apparent five exceptions in the word world, already mentioned, each cluster actually contains two morphemes (in contradistinction to initial clusters, where that is never the case).

The phoneme distribution in final clusters is not as simple as in initial clusters, naturally, since two morphemes have to be accounted for, the second of which is inevitably an inflectional suffix, and since the inventory of possibly occurring phonemes is larger than in the case of initial clusters (which totalled only eight), in fact greater for each of the three slots. The exact privileges of occurrence, in part in mirror image of initial clusters, can be diagrammed as follows:

A. first morpheme: 1 = /r,l/; /n,n,m/; /s/.

2 = /k,t,p/; /g,d,b/; /f,v/; /θ,ð/; /č,ǰ/; /š/. (not extant in this corpus).

B. Second " : 3 = /s~z/; /t~d/; /st/.

Although the configuration is more complicated than in initial clusters, it can be seen that the final-cluster distribution is also quite regular (cf. Hill 1958:77-88). For the present sample, the following combinations could be noted (with the first one listed being the normal one):

group 1	group 2	group 3	examples
C	C	C	/sports/

but also:

C	-	CC	/fɔrst/; /wɔrst/.

(note that /st/ is, in fact, equivalent to the superlative).

and: group 1	group 2	group 3	examples
-	C	CC	/nekst/;

also possible:

CC	-	C	/hərld/; kərst/;
C	CC	-	/tempt/

(note that /tempts/ would still follow the rule).

4-C clusters are possible, but are usually reduced:

C	-	C(C)C	/fərsts/;

In the following examples, close observation makes it quite clear that group three is being tapped for the inflectional ending (although the same sounds are available in groups one and two):

C	C	C	/tests/; /ǰəmpt/; /pɝənts/;

There is the odd exception transcending the scheme for English, for instance one which draws (multiply) on a previous class, viz. /kərps/, group 1, 2, 1 (cf. corpus), or /blɪ̈tst/ etc.

4. Summary

The statistical analysis of a representative sample of natural, informal speech revealed a number of characteristics of dynamic speech which set it off from static (citation form, that is pre-dynamic) language representation. Perhaps unexpected in

light of the variable character of 'fast speech' rule application is, nevertheless, the sense of great orderliness pervading dynamic speech. This may be obscured on first impression in view of the apparent jumble of phonemes within the enlarged scope of the dynamic operating unit (cf. Appendix 1), the syllabic phrase (consisting of almost 15 phonemes in succession, on the average, it will be recalled). But regularity emerges clearly once the data is viewed in terms of the dictates of the syllable, the fundamental operating unit, and the highly regular peaks and troughs of syllabic segmentation. This suggests that the key to auditory comprehension of running speech, and hence a governing feature of it per se, is syllabicity, with the general organizing principle no longer words (which may be only marginally discernible) or sentences (here dissected into self-contained bursts or runs of speech), but syllables and sequences of syllables under the suprasegmental umbrella notion 'syllabic phrase'.

To summarize, an analysis of a representative natural speech sample, investigated not from the viewpoint of rules for turning language into speech but viewed as text subsequent to actual rule application shows that despite a 60/40 consonant/vowel ratio, dynamic speech is by nature overwhelmingly sonorant and 80% voiced. Text viewed in terms of the syllable reveals great regularity in dynamic canonical shape with an orderly succession of classes of segments. Exceptions in the form of 3-C clusters are insignificantly infrequent (though semantically vital and portentous

for boundary marking). They were seen to function according to a highly regular scheme (bimorphemic in the case of postvocalic clusters), to which not a single exception could be noted.

5. Applications to ESL/EFL

Findings such as these are not only of interest to scholars of the English language; in light of recent developments and changes in focus, they are of great currency for second language acquisition research and pedagogy. Current work in L2 pronunciation reflects a fundamental change in thinking in that L2 competence now encompasses more of the oral properties of the target language and what constitutes fluent speech in it, as a short excerpt from the most recent book on the subject may demonstrate:

> 1. A focus on working with pronunciation as an integral part of, not apart from, oral communication.
> 2. A focus on the primary importance of suprasegmentals (i.e. stress, rhythm, intonation, etc.) and how they are used to communicate meaning, with a secondary importance assigned to segmentals (i.e. vowel and consonant sounds).
> 3. A special focus on syllabic structure, linking (both within words and across word boundaries), phrase-group divisions (thought group chunking and pausing), phrasal stress and rhythm patterns (Morley 1987:ii).

Regularities and principles of dynamic speech as outlined here in preliminary fashion, including the information below, may prove helpful in improving L2 learning of the spoken language:

A. For purposes of language acquisition, therefore, teachers as well as students should be aware of the fact that the canonical shape of the dynamic syllable is quite regular but will exert greater load demands when represented in basic operating units: according to the information gathered here, citation forms contain an average of 3.1 phonemes while dynamic forms may average nearly 15, an almost fivefold load increase.

B. Citation form utterances are, on the average, dynamically realized in 2.54 syllabic phrases, made up predominantly of sonorants (65%) and overwhelmingly of voiced sounds (80%); only 9.4% of all phoneme occurrences are voiceless stops, for instance, as an analysis of this speech sample shows.

C. Also, running speech can tolerate maximally five consonants in sequence (not so in pre-dynamic configurations). These obligatorily syllabize into clusters of maximally 3-C, 88% of them appearing postvocalically. Altogether, 3-C clusters make up only .63% of dynamic speech. Normally, therefore, no more than two successive consonants appear intrasyllabically, and in fact only two obstruents even appear intersyl-

labically, so that quite regular sequences of (O)(S)V(S)(O).(O)(S)V(S)(O) result.

D. Syllable boundaries are fluid and can be expected to change configuration due to restructuring and will thus alter syllable structures of citation forms in great number.

E. Frequent instantiation of ambisyllabicity blurrs syllabic peripheries; still, plus juncture does not materially contribute to the impression of the dynamic syllable since momentary, perceptible interruptions of the intonation contour were noted only for voiceless stops.

F. Despite the fact that so-called fast speech rules (an unfortunate misnomer of 'normal speech rules') are variable rather than obligatory, the covariants they produce nevertheless result in a quite orderly canonical shape (with citation form characteristics in some cases retained despite massive intervening absorption operations). Generally, the phonostylistics of dynamic speech is simpler, for instance in its less complex C-clusters, but complicated at the syllabic phrase level by the sheer number of phonemes present there on the average.*

*Financial assistance by the College of Arts and Sciences, University of Nevada Reno is hereby gratefully acknowledged.

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